Companion annual legumes for perennial grass pastures

Geoff Moore, Brad Nutt, Brad Wintle and John Titterington
DAFWA Pasture Science, Future Farm Industries CRC

The use of sub-tropical perennial grasses in the NAR continues to increase on sandy soils which are marginal or unsuitable for cropping. However, most of these perennial grass paddocks have low or nil annual legume content which limits productivity. The addition of a high quality annual legume component would both increase feed quality during the growing season and provide the nitrogen input to drive the productivity of the grasses.

The key questions for companion annual legumes relate to: (a) which species/varieties will reliably self-regenerate in competition with the perennial grasses after a once only introduction; (b) can soft-seed annual legumes be broadcast before the break of the season with frequent re-introduction; and (c) what is the most appropriate low cost, reliable method(s) of introducing annual legumes into an established perennial grass-based pasture.

Purpose

To identify companion annual legumes for perennial grass based pastures and to develop reliable, low cost methods of establishment:

1. To evaluate the potential of a range of annual legumes (varieties, lines) to establish, set-seed and regenerate under an established perennial grass pasture.
2. To test the concept of broadcasting soft-seeded annual legumes into established perennial grass pastures before the break of the season.
3. To evaluate the direct drilling of annual legumes (scarified seed) into established perennial grasses after the break of the season.
4. To evaluate the potential of twin sowing hard-seeded annual legume pod when the sub-tropical grasses are sown in spring.

SIMULATED ANNUAL LEGUME SEED BANK

This trial is evaluating whether new annual legumes with different hard-seed breakdown patterns will have superior regeneration under an established perennial pasture (panic grass, Rhodes grass) than current commercial varieties (which were selected for persistence in a crop rotation).

Trial Design A replicated small plot (10 m x 10 m plots) at Badgingarra Research Station with 4 replicates with 6 annual legume treatments (i.e. Margurita French serradella, Cadiz French serradella, Santorini yellow serradella, Hard-seeded French serradella 3.1, Yellow serradella 72.1, Blue lupins - naturalised) with 10 m wide buffers to minimise spread between treatments.

Methods: Pod was broadcast in March 2009 @ 100 kg/ha of pod except for blue lupins (25kg/ha seed) to simulate a seed bank and then lightly covered with soil. The trial was established within a 10 ha paddock and grazed with the rest of the paddock in early to mid-September and in early December.

Pasture measurements included: seedling counts, measuring the pasture biomass and pasture composition immediately prior to each grazing and the seed yields at the end of the growing season.

Results: There was excellent regeneration of all serradella treatments with seedling densities >200 plants/m^2, except for Santorini yellow serradella. The blue lupins had an average of 7 plants/m^2, which is an adequate density (Table 1).

The biomass and composition was measured prior to the first grazing in early September and all treatments had produced between 4.0 to 4.8 t DM/ha with a high annual legume content, except for Santorini yellow serradella (Total biomass 3.75 t DM/ha) but only 730 kg/ha of 'sown' annual legume (Table 1).

The legumes plots were all well grazed by the sheep, but the blue lupins were preferentially grazed down to the main stems and there was subsequently poor recovery post-grazing. The blue lupins were also affected by the fungal disease anthracnose which reduces seed yields and can also be a source of infection for narrow-leaf lupin crops.

All of the treatments had senesced or almost senesced by the second grazing in early December, except for one plot of the late flowering hard-seeded French serradella 3.1 which was green and still flowering. Samples were taken for biomass and seed yields prior to the second grazing in early December, but the samples have not yet been fully processed and analysed.

Table 1 *Seedling counts and biomass (Sept. 8th '09) in the simulated seed bank trial at Badgingarra Research Station*

Annual legume (cultivar/accession)	Average seedling counts (plants/m^2) – June 23 '09		Average biomass (kg DM/ha) - Sept. 8th '09		
	'Sown' annual legume	'Other' annual legume	Total	'Sown' annual legume	'Other' annual legume
Margurita French serradella	299	11	4616	2509	478
Cadiz French serradella	266	10	4803	2651	373
Santorini yellow serradella	38	9	3754	735	486
Hard-seeded French serradella 3.1	229	11	4709	2841	330
Yellow serradella 72.1	206	13	4054	1947	598
Blue lupins (naturalised)	7	49	4691	1522	544

Observations: With a hot, dry summer followed by a well defined break to the annual growing season in late May the conditions were favourable for hard-seeded annual legumes and this was reflected in the trial results for 2009, except for the poor regeneration of Santorini yellow serradella.

The results for Santorini were expected as the currently available commercial cultivars of yellow serradella (e.g. Charano, Santorini, Yelbini) were specifically developed for use in cropping systems. They are very hard-seeded to persist through several cropping cycles and have a delayed germination after the break of the season which can allow a 'cleaning' spray to reduce the weed burden. However, when used as a companion legume for perennial grasses this delayed germination may be a disadvantage, so we are testing experimental line 72.1 which does not have this delayed germination. To date the field results for this new serradella line are promising, but we need to measure the performance over a number of seasons.

PROOF-OF-CONCEPT- BROADCASTING SOFT-SEEDED ANNUAL LEGUMES

This trial is evaluating whether the broadcasting of soft-seeded annual legumes either each year or every couple of years is a viable alternative to relying on the regeneration of hard-seeded annual legumes.

Trial Design: The soft-seed concept trial was a replicated small plot trial with 10 m x 10 m plots at Badgingarra Research Station with 4 replicates and 8 treatments: i.e. Mandolup narrow-leaf lupins (@ 20, 30 kg/ha), Teo yellow lupins (@ 20, 30 kg/ha), Cadiz soft-seeded French serradella (@ 10, 20 kg/ha), early French serradella (experimental line @ 10 kg/ha). The Mandolup narrow-leaf lupins have low alkaloid and are essentially non-shattering, so one of the treatments will simulate a partial shattering

line, the Teo yellow lupins have moderate alkaloid content which may reduce grazing during the growing season.

Methods: The seed was broadcast on May 18 2009 prior to the break of the growing season (May 21-22 '09). The trial was established within a 10 ha paddock and grazed with the rest of the paddock.

Pasture measurements included: seedling counts, measuring the pasture biomass and pasture composition immediately prior to each grazing and the seed yields at the end of the growing season.

Results: All of the annual legume treatments established well, with average seedling densities of 15-30 and 83 to 135 plants/m^2 for lupins and the French serradella respectively (Table 2). By early spring there was good to excellent biomass in all the treatments with the serradella having an average total biomass of 3.8 to 4.4 t DM/ha, while the lupins had an average total biomass of 5.8 to 7.3 t DM/ha (Table 2).

Table 2 *Seedling counts and biomass (Sept. 8th '09) in the soft-seed concept trial at Badgingarra Research Station*

Annual legume/cultivar	Average seedling nos. (plants/m^2)		Average biomass (kg DM/ha)		
	Sown annual legume	Other annual legume	Total	Sown annual legume	Other annual legume
Cadiz French serradella (@ 10 kg/ha)	106	20.5	4017	1386	1292
Cadiz French serradella (@ 20 kg/ha)	135	30	4380	2071	868
Early French serradella (@ 10 k/g/ha)	83	26	3799	1002	1202
Mandolup narrow-leaf lupins (@ 20 kg/ha)	18	91	5832	2226	642
Mandolup narrow-leaf lupins (@ 30 kg/ha) PS	15	70	6594	2948	903
Mandolup narrow-leaf lupins (@ 30 kg/ha)	31	78	6885	3481	777
TEO Yellow lupins (@ 20 kg/ha)	17	61	6231	2411	834
TEO Yellow lupins (@ 30 kg/ha)	23	85	7284	3768	595

During the first grazing in early September both the narrow-leaf lupins and yellow lupins were preferentially grazed and within ~4 days had been grazed down to the main stems. Many plants did not recover and died, while the remainder had a weak recovery after grazing with poor growth. As a result there was little or no seed set from the lupin plots.

All of the treatments had senesced by the second grazing in early December and samples were taken for biomass (all plots) and seed yields (serradella only) prior to the second grazing, but the samples have not yet been fully processed and analysed.

Observations: Broadcasting soft seed annual legumes was highly successful in 2009, but the trial needs to be repeated over a few years with different rainfall patterns in late autumn-early winter.

There was no affect of the moderate alkaloid levels in Teo yellow lupins in reducing grazing pressure. All of the lupin plots were heavily grazed and their subsequent recovery was poor. It needs to be noted

that as the trial only represented a small proportion of the overall paddock the stock may have preferentially grazed the lupin plots for added variety in their diet.

DRILLING HARD-SEEDED ANNUAL LEGUMES AFTER THE BREAK OF THE SEASON

Three replicated small plot trials (i.e. 1 at Badgingarra R.S. and 2 at Moora) with 12 annual legume treatments (i.e. Santorini, Charano, Yelbini and experimental line 72.1 yellow serradellas; Erica, Margurita and experimental line 3.1 hard-seeded French serradellas; Dalkeith sub clover; blue lupins - naturalised; Sothis Eastern star clover; Hykon rose clover and control (not sown) with 10 m x 3.6 m plots and 5m buffers between plots (5 m x 1.5 m plots with 4 reps. Moora).

Methods: The trials were sown on June 22nd with the following sowing rates: serradella seed @ 5 kg/ha, clovers @ 10 kg/ha and blue lupins @ 25 kg/ha. The measurements included seedling counts and seed yields.

Results: Before seeding the sites were sprayed with SpraySeed (@1.5 L/ha) to set-back the perennial grasses and either kill or suppress any annual grasses or broadleaf weeds. The SpraySeed was mostly effective, although some broadleaf weeds were only suppressed and, on recovery, competed strongly with the annual legumes in late winter and spring.

The annual legumes had good establishment, but with cooler temperatures in July seedling growth was slow and by late July they were still small seedlings (except blue lupins). On the other hand, the perennial grasses recovered strongly from the knockdown spray. In spring the annual legumes were out-competed by the annual grasses, annual broadleaf weeds and perennial grasses and as a result were only a minor component of the pasture. Seed yields were visually assessed as low and were not measured.

Observations: A consistent finding from all three trials was that drilling annual legumes into established perennial grasses in late June is likely to have a low success rate, because:

- weed control is likely to be sub-optimal as sprayseed will only kill some of the weeds, while the other weeds which are suppressed will re-grow and compete strongly with the annual legume seedlings (earlier grazing or spray-graze with a selective broadleaf herbicide may help),
- the annual legume seedlings grow slowly in winter and as a result compete poorly with the broadleaf and annual grass weeds.

This strategy will be modified and repeated in 2010 if the seasonal conditions allow the annual legumes to be sown in autumn (e.g. early May).

TWIN SOWING

The twin sowing of hard-seeded serradella pod with sub-tropical perennial grasses in spring is a potential low-cost method of establishment. It refers to the broadcasting of serradella pod when the perennial grasses are sown in spring. The desired outcome is that the annual legumes subsequently germinate after the break of season in the following autumn. On the down side, any legume seed which germinates shortly after sowing in spring is unlikely to set seed, reduces the seed bank and will compete with the perennial grasses at the vulnerable seedling stage.

Trial Design: Randomized block trials with 9 treatments and 10 m x 3.4 m plots with 3 replicates at two sites. The treatments were: Santorini yellow serradella @ 50 kg pod/ha, yellow serradella experimental line 72.1 @ 20, 50 kg pod/ha, Erica French serradella @ 20, 50 kg pod/ha, experimental line and Margurita French serradella @ 50 kg pod/ha with all of these treatment the pod was broadcast in the

inter-row plus Margurita French serradella @ 20 kg pod/ha drilled with the grass seed in the furrow plus a control (grasses only).

Methods: Two replicated trials were established in early September '09 at Eneabba and Gillingarra where the pod of a range of yellow and hard-seeded French serradellas was broadcast in the inter-row between furrow sown perennial grasses (Evergreen mix @ 4.5 kg/ha with 40% germination). There was also one treatment where the pod and grass were both sown in the furrow to evaluate the effect of competition on perennial grass establishment and persistence over the first summer.

The measurements include seedling counts for the perennial grasses and serradella, while the persistence of the perennial grasses over summer will be tracked for a subset of treatments.

Results: The trials have successfully established with a good perennial density in all the plots and variable germination of the annual legumes from the pod which was broadcast. Seedling counts were taken of the perennial grasses and any annual legume seedlings which germinated in spring. For example, at Eneabba the perennial grass density ranged from 21.1 to 27.5 plants/m^2, while the number of annual legume seedlings varied from 0.2/m^2 with yellow serradella to 14.6/m^2 for Erica French serradella @ 50 kg pod/ha.

There was a single treatment where the Margurita French serradella @ 20 kg pod/ha was sown in the same seeding run as the perennial grasses rather than dropped in the inter-row. This treatment had an average of 16.6 plants/ m^2 in the seeding furrow and the increased competition resulted in the perennial grass seedlings being noticeably smaller.

Observations: The trials have uniformly good establishment, but the key is how well the serradella regenerates in autumn after the break of the season.

CONCLUSIONS

The trial results from 2009 demonstrate there may be a number of options for companion annual legumes for perennial grass-based pastures. The results need to be verified over a number of years with different seasonal conditions.

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PAPER REVIEWED BY: Brad Nutt

EMAIL CONTACT: geoff.moore@agric.wa.gov.au